

Water Pollution and Solutions

Objectives

After this lesson, students will be able to

E.4.3.1 Explain why fresh water is a limited resource.

E.4.3.2 Identify the major sources of water pollution.

E.4.3.3 Describe how water pollution can be reduced.

Target Reading Skill

Previewing Visuals Explain that looking at the visuals before they read helps students activate prior knowledge and predict what they are about to read.

Answers

Possible questions and answers include the following: **What are some household causes of water pollution?** (*Water and human wastes that are washed down sinks, toilets, and showers*) **What is sediment?** (*Rock and sand that has been eroded by water*)

All in One Teaching Resources

- [Transparency E32](#)

Preteach

Build Background Knowledge

L2

Locating Earth's Water

Display a world map or globe, and ask: **How much of Earth's surface is covered by oceans?** (*Nearly 75%; accept all reasonable estimates.*) **Where else does some form of water exist?** (*In glaciers and polar ice, in freshwater lakes and rivers, in soil, deep underground in aquifers, and in the air as vapor*) Record students' responses on the board, but do not comment on any omissions at this time.

Water Pollution and Solutions

Reading Preview

Key Concepts

- Why is fresh water a limited resource?
- What are the major sources of water pollution?
- How can water pollution be reduced?

Key Terms

- groundwater • pollutant
- sewage • pesticide
- sediment



Target Reading Skill

Previewing Visuals Before you read, preview Figure 13. Then write two questions that you have about the diagram in a graphic organizer like the one below. As you read, answer your questions.

Water Pollution

| | |
|----|----------------------------------------------------|
| Q. | What are some household causes of water pollution? |
| A. | |
| Q. | |



Discover Activity

How Does the Water Change?

1. Shine a flashlight through a clear plastic cup of water.
2. Add six drops of milk to the water and stir.
3. Shine the flashlight through the cup again. Note any differences.

Think It Over

Observing Where in the cup of water is the milk located? Could you easily separate the milk from the water?

Most of Earth's surface is covered by some form of water. Oceans cover nearly three fourths of Earth's surface. Around the poles are vast sheets of ice. From space you cannot even see many parts of Earth because they are hidden behind clouds of tiny water droplets. There seems to be so much water—it's hard to believe that it is a scarce resource in much of the world.

Water—A Limited Supply

How can water be scarce when there is so much of it on Earth's surface? **The reason is that most of the water on Earth—about 97 percent—is salt water. Salt water cannot be used for drinking or for watering crops.** In addition, about three quarters of the fresh water on Earth is in the form of ice. Finally, the supplies of liquid fresh water that do exist are not always close to where people live. For example, many cities in the southwestern United States draw their drinking water from rivers hundreds of kilometers away. And about half the people in the United States use groundwater for their drinking water. **Groundwater** is the water stored in soil and rock beneath Earth's surface.

Renewing the Supply Fortunately, Earth's supply of fresh water is renewable. As you recall from Chapter 2, water continually moves between the atmosphere and Earth's surface in the water cycle. Even though fresh water is a renewable resource, there is not always enough of it in a given place at a given time.



Discover Activity

Skills Focus Observing

Materials flashlight, clear plastic cup, water, plastic dropper, milk

Time 5 minutes

Tips In Step 3, encourage students to shine the light downward at the cup and from different angles.

L1

Expected Outcome The mixture will appear cloudy; solid particles in the milk will reflect the light so the beam does not pass easily through the cup.

Think It Over The milk is scattered evenly throughout the water and cannot be easily separated from it. The milk's solid particles could be separated by evaporating the mixture.



Instruct

Water—A Limited Supply

Teach Key Concepts

L2

Earth's Limited Water

Focus Remind students that most of Earth's water is ocean.

Teach Ask: **Why is fresh water scarce?**

(Most water on Earth is salt water, much of the fresh is in the form of ice, and fresh water is not always located near where people live.) **If water is renewable, why do water shortages occur?** (The processes of the water cycle do not produce enough water in useable form to meet human needs. The problem is worsened when droughts occur.)

Apply Have students find out where their local drinking water comes from. (Most likely from a surface reservoir, well, or freshwater lake) **learning modality: logical/mathematical**

Water Shortages Water shortages occur when people use water in an area faster than the water cycle can replace it. This is more likely to happen during a drought, when less rain than normal falls in an area. During a drought, people have to limit their water use. If a drought is severe, crops may die from lack of water.

Many places never receive enough rain to meet the water needs of their growing populations. These places must obtain water from distant sources or by other means. For example, cities in the desert nation of Saudi Arabia obtain more than half of their fresh water by removing salt from ocean water.



What is groundwater?

FIGURE 12

Fresh Water

Only fresh water can be used for drinking and household tasks.

Water Pollution

Since fresh water supplies are scarce, water pollution can be devastating. Substances that cause pollution are called **pollutants**. Some pollutants, such as iron and copper, make water unpleasant to drink or wash in. Other pollutants, such as mercury or benzene, can cause sickness or even death.

If you did the Discover activity, you saw that a few drops of milk quickly spread throughout a cup of water. You could not tell where the milk first entered the water. In the same way, pollutants can dissolve and move throughout a body of water. This is how pollution can affect areas far from its source.

Most water pollution is the result of human activities. **Wastes produced by households, agriculture, industry, mining, and other human activities can end up in water.**



Land, Water, and Air Resources

Video Preview
Video Field Trip
Video Assessment



Discovery
CHANNEL
SCHOOL
Video
Field Trip

Land, Water, and Air Resources

Show the Video Field Trip to let students observe beluga whales and help them understand how pollution affects these animals. Discussion question: **What are the probable sources of the insecticides being found in beluga whales?** (Waste materials from factories; pesticides.)

Independent Practice

All in One Teaching Resources

- Guided Reading and Study Worksheet: [Water Pollution and Solutions](#)

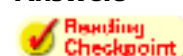


Student Edition on Audio CD

Monitor Progress

L2

Answers



Water stored in soil and rock beneath Earth's surface

Differentiated Instruction

Less Proficient Readers

L1

Organizing Information Create a table on the chalkboard with these headings: *Water Pollutants, Effects, and Keeping Water Clean*. Ask students to copy the table

and fill it in as they read. Advise them to provide details for each of the subheadings. You may choose to pair students with proficient readers for this activity. **learning modality: verbal**

Water Pollution

Teach Key Concepts

L2

Sources of Water Pollution

Focus Review the effects of pollutants.

Teach Have different student volunteers read each caption in Figure 13. Explain that pesticides build up in the food chain because as organisms take in pollutants, they eliminate some pesticides but the remainder is stored in body tissue to be consumed by the next animal up the food chain. Ask:

What is a major pollutant from agriculture that affects the food chain? (*Pesticides*)

What are sources of pollutants from industry and mining? (*Chemicals, metal wastes, heat, oil, and gasoline*) **What is a natural source of pollutants?** (*Sediments*)

Apply Encourage students to share with the class any observations they have made of examples of water pollution in their community. **learning modality: visual**

All in One Teaching Resources

- [Transparency E33](#)

Address Misconceptions

L2

Pollution From Motor Oil Changes

Focus Students may think that spills from tankers cause most of the water pollution from oil.

Teach Tell students that more oil is dumped in water from households than from oil tankers. Over 2 million people who change their own motor oil pour more than 200 million gallons of oil per year down a drain or into the garbage. This amount is more than 50 times the amount of oil released by accidental tanker spills in 2000. The used oil from one oil change can pollute 1 million gallons of groundwater.

Apply Ask: **How should motor oil be safely disposed of?** (*It should be taken to a recycling center.*) **learning modality: logical/mathematical**

Lab zone Try This Activity

Is There Tea There?

In this activity, you will see how difficult it can be to remove pollutants from water.

1. Pour some cooled herbal tea into a clear plastic cup. Observe the color of the tea.
2. Place a paper filter in a funnel. Fill it half way with crushed charcoal. Put the funnel on top of another clear plastic cup.
3. Slowly pour the tea into the funnel so it collects in the plastic cup.
4. Observe the filtered liquid.

Observing How successful were you in removing the pollutant (tea) from the water?

Household Sewage The water and human wastes that are washed down sinks, toilets, and showers are called **sewage**. If sewage is not treated to kill disease-causing organisms, the organisms quickly multiply. People can become ill if they drink or swim in water containing these organisms.

Agricultural Wastes Animal wastes, fertilizers, and pesticides are also sources of pollution. Rain can wash animal wastes and fertilizers into ponds, where they cause algae to grow quickly. The algae soon cover the pond, blocking light from reaching plants in the pond and killing the plants.

Pesticides are chemicals that kill crop-destroying organisms. Because pesticides are usually spread over large, open areas, they can pollute bodies of water. Even low levels of chemicals in the water can build up to harmful concentrations as they move through the food chain.

Industry and Mining Wastes Some plants, mills, factories, and mines produce wastes that can pollute water. Chemicals and metal wastes can harm organisms that live in bodies of water. Animals that drink from polluted bodies of water or eat the organisms that live in them can also become ill.

Sediments Water that causes erosion picks up **sediments**, or particles of rock and sand. Sediments can cover up the food sources, nests, and eggs of organisms in bodies of water. Sediments also block sunlight, preventing algae and plants from growing. This affects organisms that rely on the algae and plants.

Heat A pollutant is usually thought of as an added material. But heat can also have a negative effect on a body of water. Some factories and power plants release water that has been used to cool machinery. This heated water can kill organisms living in the body of water into which it is released.

Oil and Gasoline One of the most dramatic forms of water pollution is an oil spill. You may have seen news reports showing beaches covered with sticky black oil, or volunteers cleaning oil from birds. It can take many years for an area to recover from an oil spill.

Another water pollution problem is caused by oil and gasoline that leak out of damaged underground storage tanks. The pollution can be carried far away from a leaking tank by groundwater.



Why is heat considered a water pollutant?

Go online
PLANET DIARY

For: More on cleaning up oil spills
Visit: PHSchool.com
Web Code: ced-5043

Lab zone Try This Activity

Skills Focus Observing

Materials cooled herbal tea, 2 clear plastic cups, paper filter, funnel, crushed charcoal

Time 10 minutes

Tips Use a tea that has a distinct color, and brew a strong solution.

L1

Expected Outcome The filtered tea will be lighter in color than the unfiltered tea.

Extend Have students suggest an explanation for any changes they observe in the tea after pouring it through the funnel. (*The charcoal and filter will remove some but not all of the tea.*) **learning modality: visual**

Go online
PLANET DIARY

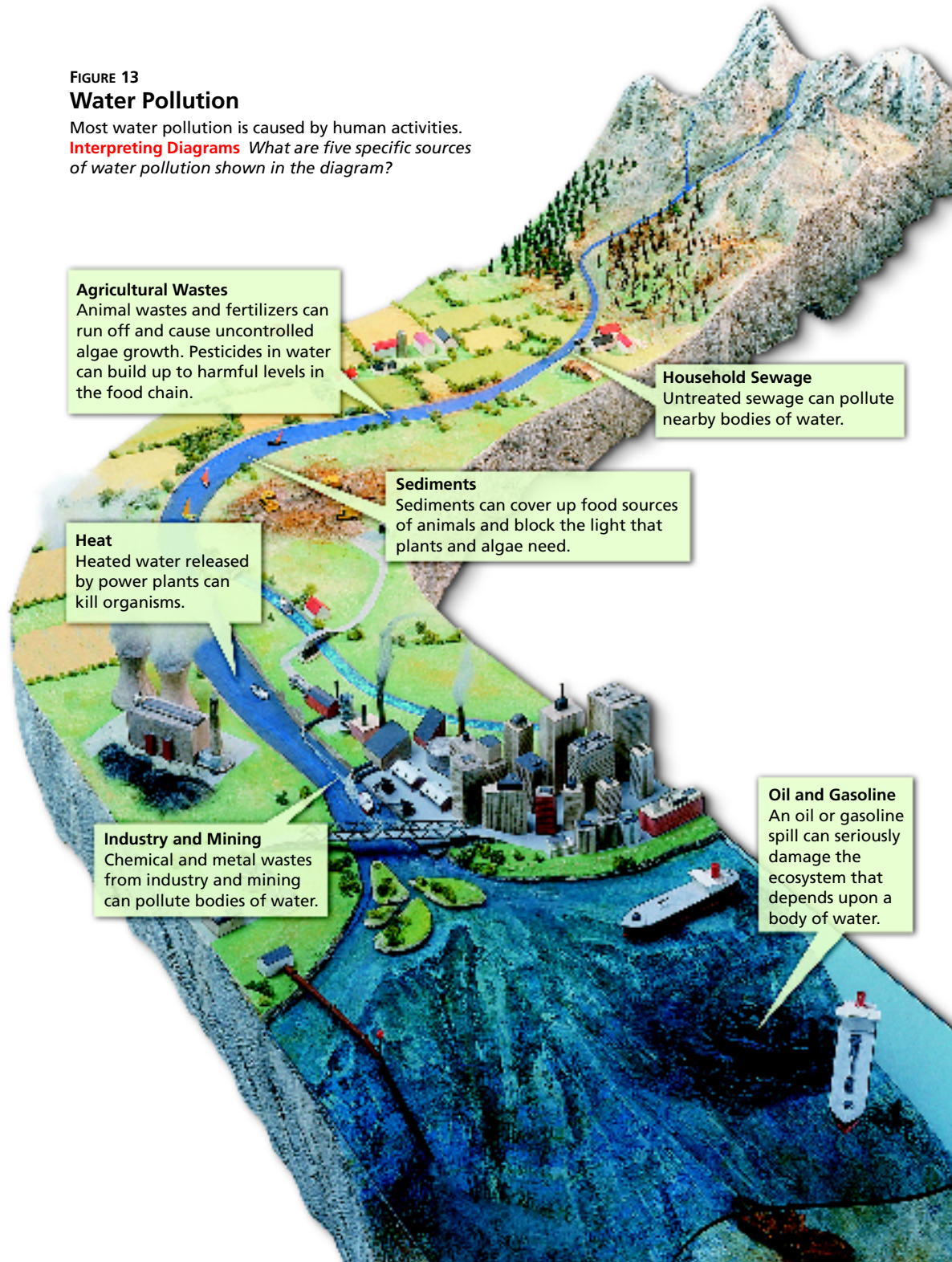
For: More on cleaning up oil spills
Visit: PHSchool.com
Web Code: ced-5043

Students can review oil spills in an online interactivity.

FIGURE 13

Water Pollution

Most water pollution is caused by human activities.
Interpreting Diagrams What are five specific sources of water pollution shown in the diagram?



Cleaning Up Oil Spills

Materials small bowl, water, cooking oil, dropper, paper towels, graduated cylinder or cup calibrated in mL

Time 15 minutes

Focus Ask students how difficult they think it is to clean up an oil spill.

Teach Have students work in groups to fill a bowl halfway with water and then add 25 mL of cooking oil. Instruct them to wipe out the cylinder with a paper towel. Then have students try to remove the oil from the water with the dropper, placing the removed oil into the graduated cylinder. After students have worked for about 15 minutes, have them observe the liquid in the graduated cylinder and note that the water and oil have separated. Ask: **How much oil have you removed?** (*Students probably will have recovered very little oil.*) **Is oil still on the water in the bowl? How can you tell?** (*Students will most likely respond that the water surface still has an oily sheen or globules of oil.*)

Apply Tell students that many methods are used to clean up large oil spills, such as mechanically or chemically breaking up the oil into smaller amounts. **learning modality: kinesthetic**

Monitor Progress

Oral Presentation Call on students at random to name sources of water pollution and their effects.

Answers

Figure 13 Any five of the following: animal wastes, fertilizers, pesticides, heated water, untreated sewage, sediments, chemical wastes, metal wastes, oil and gasoline spills

Assessing Checkpoint Heated water can kill organisms living in the body of water into which it is released.

Keeping Water Clean

Teach Key Concepts

L2

Reducing Water Pollution

Focus Remind students that everyone is responsible for water quality.

Teach Ask: **How are disease-causing organisms kept out of drinking water?** (*Wastewater is treated to kill the organisms.*)

What can industries do to keep water clean?

(*Recycle or reduce their wastes, or produce less harmful waste*)

Why can't bacteria that break down oil take care of large oil spills?

(*There is too much oil for them to break down.*)

What can an individual do to help prevent water pollution?

(*Never pour hazardous chemicals down the drain*)

Apply Work with students to help them identify places (through the phone directory, the Internet, or state EPA office) where their families can drop off hazardous materials.

The EPA can provide information about hazardous household materials that should not be disposed of down the drain or in the regular trash. **learning modality: verbal**

Help Students Read

L1

Identifying Main Ideas Have students write a main idea sentence for each subheading under *Keeping Water Clean*. For example, for *Sewage Treatment*, a main idea sentence might be: A typical sewage treatment plant uses several steps to clean water before returning it to the environment.

FIGURE 14

Sewage Treatment

Riverbank State Park in New York City is a huge recreational complex built over a sewage treatment plant. **Problem Solving** Why is this a good solution for a big city?



Keeping Water Clean

By working together, government, industries, and individuals can improve water quality in the United States. Federal laws such as the Clean Water Act regulate the use of certain substances that can pollute water. State and local laws also regulate the use and cleanup of water pollutants.

The keys to keeping water clean are proper sewage treatment, the reduction of pollutants, and the effective cleanup of oil and gasoline spills. There are also some important ways that people can reduce water pollution at home.

Sewage Treatment Most communities treat wastewater before returning it to the environment. A typical treatment plant handles the waste in several steps. During primary treatment, the wastewater is filtered to remove solid materials. Then it is held in tanks where heavy particles settle out. During secondary treatment, bacteria in the system break down the wastes. Sometimes the water is then treated with chlorine to kill disease-causing organisms.

Some communities have come up with creative ways to deal with sewage treatment plants. In Figure 14, you can see Riverbank State Park in New York City. It is a park, marketplace, and sports facility built on top of a sewage treatment plant. The city now has a treatment plant and a park in half the usual space.

Reducing Pollutants Instead of releasing wastes into the environment, industries can recycle their wastes to recover useful materials. Once such programs are underway, companies often find they save money as well as reduce pollution. Other companies change their processes to produce less waste or less harmful waste. For example, some industries use natural fruit acids as cleaning agents rather than toxic solvents. Likewise, farmers are finding alternatives to toxic pesticides and fertilizers.

Lab zone Try This Activity

Getting Clean

In this activity you will see how Earth's fresh water is purified in the water cycle.

1. Pour 15 mL of water into a plastic cup.
2. Add a few drops of food coloring and half a teaspoon of sugar. Stir until the sugar is dissolved.
3. Put the cup in the sunlight in a place where it will not be disturbed.
4. Check on the cup twice a day until all the water has evaporated. Observe what remains in the cup.

Making Models What do the sugar and food coloring represent? What happens to the water in this activity?

Lab zone Try This Activity

Skills Focus Making models

Materials water, plastic cup, spoon, graduated cylinder, food coloring, sugar

Time 10 minutes, plus 5 minutes for follow-up observations on several days

Tips Supply room-temperature water, not hot water, as hot water will produce a super-saturated solution.

L1

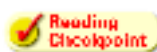
Expected Outcome Sugar crystals and a tint from the food coloring will remain in the cup. These materials represent dissolved substances that are left behind when water evaporates. The liquid water changes to water vapor.

Extend Let students repeat the activity, using other substances in the water, such as milk, salt, and baking soda. **learning modality: visual**

Cleaning Up Oil and Gasoline Spills Oil is a pollutant that nature can handle in small amounts. Bacteria that break down oil live in the ocean. When oil is present, the bacteria multiply quickly as they feed on it. As the oil disappears, the bacteria population dies down. But in the case of a large spill, bacteria cannot clean up the spill fast enough. It takes the hard work of many scientists and volunteers to minimize environmental damage from large spills.

Gasoline or oil that leaks from an underground tank is hard to clean up. If the pollution has not spread far, the soil around the tank can be removed. But pollution that reaches groundwater may be carried far away. Groundwater can be pumped to the surface, treated, and then returned underground. This, however, can take many years.

What You Can Do It is easy to prevent water pollution at home. Some common household water pollutants are paints and paint thinner, motor oil, and garden chemicals. You can avoid causing water pollution by never pouring these chemicals down the drain. Instead, save these materials for your community's next hazardous waste collection day.



Why are leaks from underground oil tanks hard to clean up?



FIGURE 15
Cleaning Up Oil Spills
After an oil spill, a volunteer gently cleans oil from the feathers of a gannet, a large seabird.

Monitor Progress L2

Answers

Figure 14 It can use the same space for two purposes.



If pollution reaches groundwater, it may be carried far away.

Assess

Reviewing Key Concepts

1. a. Most water covering Earth is salt water. Other water is in the ice caps. **b.** 0.75%
c. Possible answer: A lot of energy would be required to melt the water, and the amount of water would likely not be enough to correct shortages. Also, transportation of the ice or water might be expensive.

2. a. Human activities that relate to households, agriculture, industry, and mining **b.** Sprayed pesticides can land directly on the water or can be washed by rain into a body of water, such as a river, and flow downstream.

3. a. Sewage treatment, reducing pollutants, and effective oil and gasoline spill cleanup
b. The steps are (1) filtering out solid particles; (2) settling out of solids; (3) bacterial breakdown of wastes; (4) chemical disinfectant (chlorine) **c.** Possible answers: Laws that would prevent individuals and industries from dumping pollutants into waterways, require polluters to be responsible for cleanup, require the payment of large fines for polluting, and require proper sewage treatment

Reteach L2

Write an outline of this section on the board, using the headings and subheadings. Ask students to name important details as you fill them in.

All in One Teaching Resources

- [Section Summary: Water Pollution and Solutions](#)
- [Review and Reinforce: Water Pollution and Solutions](#)
- [Enrich: Water Pollution and Solutions](#)

Section 3 Assessment

Target Reading Skill Previewing Visuals Refer to your questions and answers about Figure 13 to help you answer Question 2 below.

Reviewing Key Concepts

- a. Reviewing** If most of Earth is covered with water, why is fresh water a scarce resource?
b. Calculating If only 3 percent of the water on Earth is fresh water, and 75 percent of that fresh water is frozen, what percent of the water on Earth is liquid fresh water?
c. Predicting A classmate suggests that the solution to water shortages is to melt some icebergs and transport the water to areas that need water. What are two problems with this plan?
- a. Listing** Name four types of human activities that can be sources of water pollution.
b. Relating Cause and Effect Explain how a farmer spraying fields with pesticides can pollute a river miles away.

- a. Identifying** What are three ways that water pollution can be reduced?
b. Sequencing List in order the steps of wastewater treatment.
c. Making Judgments What kinds of laws do you think would result in the greatest reduction in water pollution? Explain.

Writing in Science

Dialogue Suppose that a sewage treatment and recreation complex like the one in Figure 14 has been proposed for your town. Write a one-page dialogue in which you and another person from your town debate whether this is a good idea. (*Hint: The speakers must hold opposing viewpoints.*) Be sure to support all opinions with specific details.

Lab zone Chapter Project

Keep Students on Track Advise students to finish the drawings of their models and attach a list of the materials they plan to use in their product. Meet with students individually to offer guidance if they are having difficulty designing their product.

Writing in Science

Writing Skill Persuasion

Scoring Rubric

- Includes clear opinions from opposing viewpoints; support is clear and strong
- Includes all criteria, but one or both arguments are not convincing
- Includes little support for either side
- Includes vague opinions and lacks support